REMARKS

This application contains claims 1 – 4, 6-11, 13, 14, 16 – 18, and 32-35, amended as set forth above. Claims 19 – 30 are withdrawn. Claim 12 and 15 were cancelled earlier. Claims 16 and 17 are hereby cancelled in favor of a Divisional application directed to withdrawn claims 19 – 30 (i.e. a method of making a fuel cell current collector).

A number of claims are said to be allowable if rewritten in independent form including all of the limitations of the base and intervening claims. To this end:

(A) the limitations of claims 1 and 5 have been included in new claim 33, and claim 5 has been cancelled;

(B) the limitations of claims 1 and 31 have been included in new claim 34, and claim 31 has been cancelled;

(C) the limitations of claims 1, 18 and 32 have been included in new claim 35, and claim 18 has been cancelled;

(D) Claims 2-4, 6 - 8 and 11, 13, and 14 are dependant on new claim 34, and are allowable therewith; and

(E) Claims 9 and 10 are dependant on new claim 33, and are allowable therewith.

Claims 1and 32 remain unaltered, and stand rejected under 35 USC 103(a) over Cisar et al. 6,562,507 in view of either Braun et al. 2002/0039675 A1, or Bisaria et al. 6,379,795 B1, on the principal grounds that it would be obvious to substitute the "composite" current collector substrate of either Braun or Bisaria for the metal current collector substrate of Cisar. Applicants' respectfully traverse the rejections on the principal grounds that (1) both the Cisar-Braun and the Cisar-Bisaria combinations are improper because no motivation for the proffered combinations has been shown, and (2) Cisar et al. teaches away from such combinations.

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THE INVENTION

The present invention relates to PEM fuel cells having current collectors made from composite materials (i.e. conductive particles in a polymer matrix). More particularly, the invention seeks to reduce the contact resistance between such composite current collectors and a contiguous porous gas-diffusion media. To this end, Applicants provide the composite current collector with a hyperconductive (i.e. a higher conductivity than the composite) surface layer that engages the porous gas-diffusion media and serves to shunt electrical current passing through the media to those conductive particles of the composite that reside in the current collector at the interface between the hyperconductive surface layer and the composite. In this regard, see page 3 line 27 to page 4 line 9 of Applicants' specification for a detailed description of the problem solved by Applicants' invention. The present invention can so reduce the contact resistance between a composite current collector and the diffusion media that PEM fuel cell stacks can be made smaller, require less stack compression, are more efficient, and have lower heat loads. Reducing the stack compression alone improves stack durability, permits the use of thinner side and end plates, improves gas flow under the lands of the flow field, and provides more uniform current distribution.

In one embodiment, the entire current collector is made from the composite material. In another embodiment, the current collector comprises one or more layers of metal coated with the composite material which, in turn, is covered with the hyperconductive layer. According to a preferred embodiment, the hyperconductive surface layer comprises a plurality of oxidation-resistant and acid-resistant electrically conductive particles embedded in a surface of the composite so as to provide a higher concentration of conductive particles at the surface than throughout the remainder of the composite.

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THE CITED ART

Seeking to eliminate composite materials from current collectors, Cisar et al. 6,562,507 discloses a unitized, metallurgically-bonded, corrosion-resistant, porous metal bipolar electrode subassembly that combines the functions of gas distribution, gas diffusion, current-collection and gas barrier. Cisar expressly seeks to replace composites with low-cost, low-volume, light-weight, electrically/thermally conductive, corrosion-resistant, porous metal electrode subassemblies. Cisar's electrode subassembly comprises a porous metal gas-diffusion layer metallurgically bonded (i.e. welding, brazing, soldering, sintering, fusion-bonding, vacuum-bonding or combinations thereof) to a porous metal flow field which, in turn, is metallurgically bonded to a metal gas-barrier/current-collector layer. The gas-diffusion layer may comprise carbon fiber/powder in a hydrophobic binder (e.g. PTFE) having a metal current collector therein. Gold plating the porous metal flow field protects it from corrosion.

Braun et al 2002/0039675 A1 and Bisaria 6,379,795 are similar in that they both disclose fuel cells having composite current collectors comprising conductive particles (e.g. carbon/graphite) in a polymeric matrix. The composite current collectors of Braun et al and Bisaria are the same sort of current collectors that Cisar et al. seeks to eliminate.

THE REJECTIONS

The Examiner has rejected claims 1 and 32 as being obvious over Cisar in view of Braun or Bisaria. More specifically, he concludes that it would "*...have been obvious to one of ordinary skill in the art to use the conductive polymer composite as the substrate of the current collector on the fuel cell of Cisar, because Braun et al. teach the polymer composites exhibit good corrosion resistance, electrical conductivity and thermal conductivity in highly corrosive environment*". Not so. Cisars' gold coating is needed to protect the titanium from corrosion. Brauns'/Bisaria's composites, on the other hand, are

inherently corrosion-resistant, and require no protective coatings. Hence, there would be no motivation to gold coat Braun's/Bisaria's composite current collectors to protect them from corrosion.

In one effort to find motivation for the proffered combination of references, and referring to the gold coating, the Examiner argues that: *"It is evident that the metal coating serves to enhance the fuel cell performance during operation in addition to providing protection over the substrate. Similar improvement can be expected when the metal coating is applied onto the other type of current collector substrates, such as a conductive polymer composite ....Thus the use of noble metal coating serves multiple functions and is not limited to corrosion prevention."* Suffice to say, neither Cisar, Braun, Bisaria nor the Examiner point to any function for the gold plating, other than corrosion protection, and none is "evident" to Counsel for Applicants.

In another effort to find motivation for combining Cisar and Bisaria, the Examiner contends that it would be obvious to substitute Bisaria's composite current collector for Cisars' metal current collector because Bisaria teaches that *"polymer composites exhibit excellent strength and stiffness as current collectors in the fuel cells."* Suffice to say, Cisar's all-metal current collector is stronger, and more conductive than Bisaria's composite current collector. Hence, there would be no motivation to substitute the weaker poorly- conductive composite of Basaria for the stronger/more-conductive metals of Cisar.

Clearly no motivation for combining the references has been shown, and accordingly the combination is improper.

Finally, but no less Importantly, Cisar teaches away from the proffered combinations of references. In this regard, for no less than four columns of text in the specification (i.e. columns 1 – 4), Cisar deplores and decries the the use of composites as current collectors in fuel cells. Indeed, the entire thrust of Cisar's invention is to eliminate composite current collectors from fuel cells, and to replace them with metal current collectors. How

then can it be said to be "obvious" to substitute composites for Cisar's metals? It can't, and it would be a non-sequitor to contend otherwise.

The proffered combinations of Cisar with Braun or Bisaria are seen to be naught but the product of hindsight illuminated by Applicants' disclosure, and not the result of any teachings found in the references themselves or elsewhere. As such, the Cisar-Braun and Cisar–Bisaria combinations are improper, and withdrawal of the rejection of claims 1 and 32, based on those combinations, is respectfully requested.

The amendments introduce no new matter or require further search. In view of the foregoing, the Examiner is respectfully requested to enter the aforesaid amendments, to reconsider and allow this application as amended, and to pass it to issue at his earliest convenience.

Respectfully submitted

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